Behavioural Response Study 2008

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LONG-TERM GOALS

This is the report of the second behavioral response study to be carried out on beaked and pilot whales in which these animals, and other species, were exposed to carefully measured doses of underwater sound while their responses were being measured. The study is seen as a step in a series of similar experiments that are designed to safely identify the behavioral mechanisms that may be involved in the causal chain of events leading from exposure to some types of man-made underwater sound to mass strandings of beaked whales and to test whether this risk extends to other cetaceans.

OBJECTIVES

This short report describes the preliminary results of a Behavioral Response Study of deep-diving cetaceans carried out in 2008 (BRS-08). The rationale for this study comes from a hypothesis that some types of sonar signals can affect the behavior of some deep-diving odontocete cetaceans, especially beaked whales, and may lead to strandings on some occasions. The study was designed to examine the response of cetaceans to sonar sounds and control sounds.

	Primary objectives	**Achievements**
	Increase the sample size of MFA playbacks and controls achieved in 2007	The sample size was increased but not as much as had been hoped
	Measure the received levels of sonar sound that produce this response	Achieved
	Investigate variation in responses in relation to context and species	Achieved: 4 species were investigated
	Include at least one more killer whale playback to examine whether the response of beaked whales might be explained by confusion between sonar signals and killer whale calls	Not achieved
	Compare responses to MFA sonar signals vs more spread spectrum signal with similar overall bandwidth, duration, and timing	Achieved in some species

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14. ABSTRACT

This is the report of the second behavioral response study to be carried out on beaked and pilot whales in which these animals, and other species, were exposed to carefully measured doses of underwater sound while their responses were being measured. The study is seen as a step in a series of similar experiments that are designed to safely identify the behavioral mechanisms that may be involved in the causal chain of events leading from exposure to some types of man-made underwater sound to mass strandings of beaked whales and to test whether this risk extends to other cetaceans.

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	Aspirational objectives	
	Characterize whether and how responses differ between different age/sex/ stages in life cycle/behavioral contexts, and also between different types of sound	Not achieved
	Begin to build a population-level dose:response relationship that could be used to help predict the probability of inducing a behavioral response that could lead to stranding	Not achieved
	Examine whether the responses in beaked whales are also present in other species	Achieved to some extent

RESULTS

A total of 6 playback experiments were conducted on 4 species of odontocete cetacean. This adds to 3 playbacks conducted during 2007. In addition, observations were made of odonticetes vocalizations at a group/population level using the AUTEC hydrophone array during playbacks. Underlying habitat mapping also provided an insight in to beaked whales distributions at AUTEC that may be independent of anthropogenic acoustic activity. As in integrated data set, this provides a significant advance in our understanding of the responses of odonticetes, and beaked whales in particular, to MFA.

The operations were highly constrained mainly by a succession of tropical storms and hurricanes that threatened the region during the time of the study. This meant that the number of playback achieved was lower than had been expected if weather conditions had been the average for the time of year.

The extensive data sets emerging from this study will require to be analyzed in detail. Integrating across the results from both BRS-07 and BRS-08 as well as analyses of likely beaked whale responses to simulated sonar at the group/population level, the emerging pattern of response is as follows:

(i) Based upon multi-year photo-identification and habitat mapping, Blainvilles beaked whales are a resident species within the study area and individuals forage within the study area over multiple years. They appear to be able to survive, breed and forage successfully within this habitat in spite of considerable military acoustic sources, including on occasions MFA used at full power. Beaked whale distributions are generally congruent with apparent food availability within the water column.

(ii) Beaked whales are sensitive to noise, even at levels well below expected TTS (~160 dB re 1 µPa). This sensitivity is manifest by an adaptive movement away from a sound source. BRS observed this response irrespective of the signal transmitted within the band width of mid-frequency active sonars. This suggests that beaked whales may not respond to the specific sound signatures. Rather they may be sensitive to any pulsed sound from a point source in this frequency range. The response to such stimuli appears to involve maximizing the distance from the sound source.

(iii) The observations from the focal animal studies carried out on beaked whales during BRS are aligned with observations made during BRS of population-level movements of beaked whales that may have occurred in response to BRS activities (but require further analysis), as well as observation carried out by NUWC during sonar exercises in which full power MFA is being used. Overall, it appears that beaked whales move out of the region in which MFA is being used.

(iv) Other species appear to be less sensitive to MFA and control sounds than beaked whales. Although reactions to sonar sounds and control sounds were observed in some cases, there was little consistency in the responses and none of these responses suggested a reaction that was hazardous to these species.

In total, there have been 9 playbacks on animals, 5 of BRS_PRN1 and 4 of BRS_MFA1. For each sequence of transmissions, a full ramp up sequence was performed starting at 160 dB through maximum target source level of 211 dB, increasing 3 dB every 25 seconds and continuing transmissions for approximately 5 minutes at full power for a shallow source depth. When source was deployed deep, transmissions were ceased when chief scientist called for stop transmission. Table 1 summarizes each event and species.

Table 1 Summary of BRS 08 playbacks

Date	Waveform Sequence	Tagged Species	Ramp-up # xmn	Max SL #xmn	Source depth (m)	Comments
22-Sep	PRN 1	Short finned pilot whale	16	14	23.4	1 transmission missed duing ramp up, lost tag
	MFA 1	Short finned pilot whale	17	14	23.4	lost tag (same animal as above)
26-Sep	PRN 1	False killer whale	17	13	25.6	
	MFA 1	False killer whale	17	14	25.6	
27-Sep	PRN 1	Blaineville's beaked whale	17	3	66	Stopped playback when M3R notified that whale stopped clicking
28-Sep	MFA 1	False killer whale	17	13	25.6	
	PRN 1	False killer whale	17	13	25.6	Source was towed at 0.5kts during transmission
29-Sep	PRN 1	Short finned pilot whale	17	13	25.6	
	MFA 1	Short finned pilot whale	17	13	25.6	
		Melon headed whale				2nd tagged whale, same playback

Playback example:

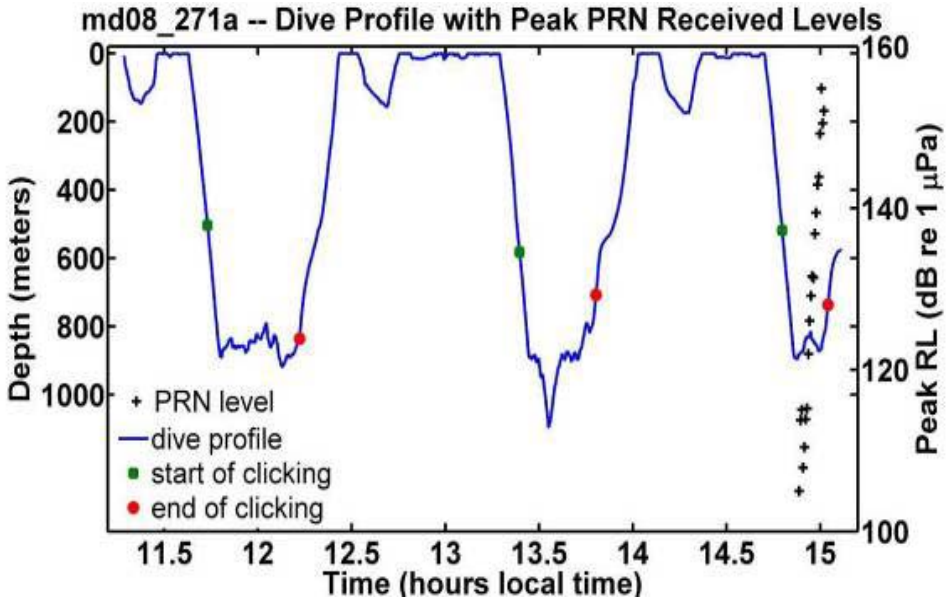

Figure 1: Blainesville's beaked whale - 27 September dive profile. The playback was during the last dive.

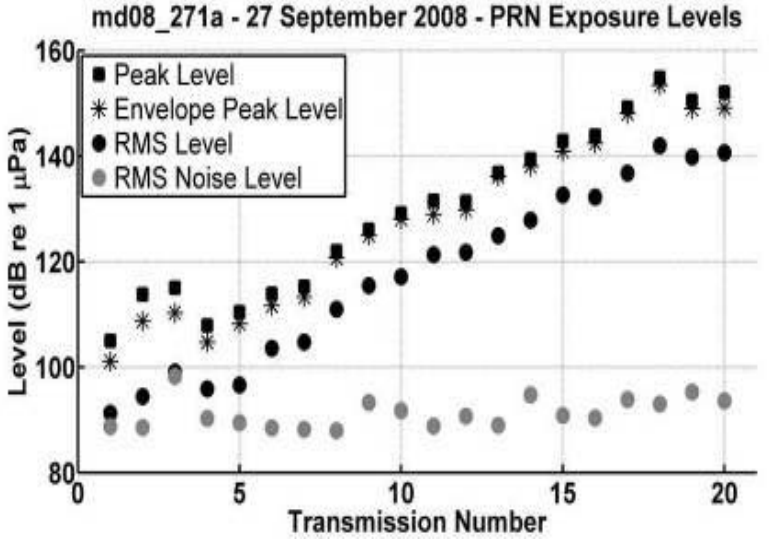

Figure 2: Received levels of sonar sound during the playback to a Blainville's beaked whale

A statistical framework has been developed to allow analysis of the kinds of temporally autocorrelated data emerging from these types of playback studies. The primary difficulty in analyses of these types of data are the low numbers of tagged individuals (only one available here) and their strongly correlated nature, due to fine scale, repeated measurements through time. Purpose-built computer-intensive methods have been developed for the analysis of univariate and multivariate tag data. This

involves *landmark analyses* for the analysis of dive shape. These analyses indicated that dive shape during the playbacks was significantly different from controls.

A comprehensive assessment has also taken place of the monitoring and mitigation undertaken during the experiments. It was obviously our objective not to cause any lasting harm to any animals. The outcome of the assessment shows no evidence of harm having been caused. In fact, the beaked whale that had been exposed to a playback in 2007 was re-sighted again in 2008. The detailed analysis suggest ways in which it may be possible to focus monitoring and mitigation in a manner that will make it at least as effective but considerable less costly.

IMPACT/APPLICATIONS

Scenarios for stranding that could be derived from these results mainly involve situations in which there is inadvertent “pursuit” of cetaceans because of the movement of vessels operating MFA. Such “pursuit” could occur as a result of specific bathymetric or oceanographic conditions and could result in magnification of the adaptive reactions observed in BRS. Beaked whales, and to a lesser extent other species, could suffer trauma including many of the pathologies observed in stranded specimens under this scenario. This suggests the most effective mitigation could be to (a) ensure there is an appropriate period of ramp up (possibly over several days) in a region in advance of any use of MFA and (b) to avoid the kind of regions and habitats in which “pursuit” is possible.

An extensive list of recommendations has been provided about the conduct of playback experiments on odontocete whales. Experiments on beaked whales require flat-calm conditions but also require the presence of a substantial sound source that needs to be carried by a large vessel. The combination of the inevitable long times spent waiting for appropriate working conditions and the high costs of having a vessel on standby to carry the sound source mean that these experiments are very difficult to conduct.